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Engagement in Maximally-Assisted therapy and adherence to antiretroviral therapy among a cohort of Indigenous people who use illicit drugs

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Abstract

Throughout the world, Indigenous populations experience a disproportionate burden of HIV infection. Maximally-assisted therapy (MAT) is an interdisciplinary care intervention that includes ART dispensation to support individuals with a history of addiction and homelessness. This study sought to longitudinally evaluate the relationship between engagement in MAT and achieving optimal adherence using data from an ongoing cohort of HIV-positive individuals who use drugs in Vancouver, Canada, where HIV/AIDS treatment is offered at no cost. Between December 2005 and November 2016, 354 HIV-positive Indigenous participants were enrolled and data were analyzed using generalized mixed-effects (GLMM) and marginal structural modeling. In both multivariable analyses, engagement in MAT was independently associated with optimal adherence to ART (GLMM: AOR=4.92, 95% CI: 3.18–7.62; marginal structural model: AOR=5.76, 95% CI: 3.34–9.96). MAT-based programmes could be a part of a renewed evidence-base to elevated levels of preventable HIV/AIDS-associated morbidity, mortality and viral transmission among Indigenous peoples in Canada.

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Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of British Columbia and Providence Health Care research ethics board, the Tri-Council policy statement for research involving human participants, as well as the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent: Informed consent was obtained from all individual participants included in this study.

Keywords

antiretroviral therapy; HIV interventions; people who use drugs; HIV; Indigenous people; Canada

INTRODUCTION

Despite remarkable improvements in HIV prevention and treatment in the last decade, Indigenous peoples in Canada experience a disproportionate burden of HIV/AIDS. In the province of British Columbia, Indigenous peoples comprise approximately 5% of the population, yet accounted for 12.6% of new HIV infections in 2011/2012 [1]. Compared to the non-Indigenous population of Canada, Indigenous peoples experience a 3.6-fold increase in the burden of HIV incidence (9.2 per 100,000 population vs. 29.9 per 100,000 respectively) [2]. As such, evidence-based interventions are urgently required to reduce the burden of HIV/AIDS-associated morbidity, mortality and transmission among Indigenous peoples in Canada.

The benefits of potent antiretroviral therapy (ART) in reducing morbidity and mortality among HIV-positive individuals and curbing onward viral transmission are increasingly well understood [3]. Unfortunately, not all individuals living with HIV/AIDS have benefited equally from these life-saving treatments, including Indigenous peoples and people who use illicit drugs (PWUD) [4–6]. In response, various innovative and culturally-tailored programs have been developed in an effort to increase access and adherence to ART among Indigenous individuals living with HIV disease.

Directly-observed therapy (DOT) programmes have been successfully adapted from their original objective of treating tuberculosis to promote adherence to ART among vulnerable populations living with HIV/AIDS across various settings [7–9]. In 1999, the maximally-assisted therapy (MAT) programme was developed as a form of DOT that included additional intensive wrap-around services serving Vancouver's Downtown Eastside, a post-industrial neighbourhood with a large open drug market and high levels of illicit drug use, poverty and HIV infection [10]. Specifically, MAT-based programmes go beyond DOT to address multiple barriers to care, including, housing instability, substance use and mental health issues faced by HIV-positive individuals. In Vancouver, the programme is located at a community health clinic in the Downtown Eastside, funded by the provincial government and clients are referred by health care providers whom are typically treatment naïve or disengaged from care [10]. For Indigenous clients, the Vancouver Native Health Society refers individuals in need of HIV treatment and support to the MAT programme, while providing continual holistic cultural support [11]. The MAT programme employs a multidisciplinary team of social workers, nurses, pharmacists, and clinicians and unique to this type of program, access to on-site pharmacists. All of the client's prescription drugs are transferred to the clinic once they are enrolled in the programme, and the pharmacist provides advice on drug-drug interactions, optimal adherence and ensures continuity of access to ART if the client is incarcerated, hospitalized or enters addiction treatment [10]. Additional services include: the provision of complex HIV primary care, meals, arrangement of specialist appointments, referrals to access legal, social, mental health, and addictions

services, and, when patients miss appointments, outreach workers will meet them in the community or at their home to deliver medication [12]. While MAT-based programmes have been previously evaluated in relation to adherence among the homeless [12], and injection drug users [13], the impact of MAT among Indigenous individuals living with HIV has yet to be evaluated.

Marginal structural models are an innovative statistical approach used for causal inference in epidemiology. They are particularly useful when a randomized controlled trial may not be ethically justified or when the design of a controlled trial may not be representative of the real-world application of the intervention [14, 15]. In the present study, we used marginal structural models to estimate the effect of being engaged in a MAT-based programme on the likelihood of achieving optimal adherence to ART among a cohort of HIV-positive Indigenous individuals who use illicit drugs in Vancouver, Canada.

METHODS

Data for this analysis were collected from the AIDS Care Cohort to Evaluate Access to Survival Services (ACCESS), an open and ongoing community-recruited prospective cohort study of HIV-positive illicit drug users in Vancouver, Canada [16]. Beginning in 2005, participants were recruited through self-referral and extensive street outreach from Vancouver's Downtown Eastside. Individuals were eligible to participate in ACCESS if they were age 18 or older, HIV-seropositive, had used illicit drugs other than, or in addition to, cannabis in the month prior to enrolment, and provided written informed consent.

At baseline and semiannually, participants complete an interviewer-administered questionnaire soliciting information on demographics, drug use patterns, and related risk factors and exposures. At each visit, participants also complete an examination by a study nurse and provide blood samples for serologic analyses. At recruitment, participants provide their personal health number, a unique and persistent identifier issued for billing and tracking purposes to all residents of British Columbia by the government-run universal and no-cost medical system. Information gathered at each interview is augmented by comprehensive information on HIV care and treatment outcomes from the local centralized HIV/AIDS registry, which has been described previously [17]. Specifically, through a confidential linkage, a complete clinical profile of all CD4 T-cell counts, HIV-1 RNA viral load (VL) observations and dispensation of specific antiretroviral agents for each participant are obtained. At each study visit, participants are compensated $30. The Providence Health Care/University of British Columbia Research Ethics Board has approved this study.

The study period for this analysis was from December 2005 to May 2014. Consistent with the approach used previously [18], we defined participants as Indigenous if they self-reported Indigenous ancestry at the baseline interview, defined in this context as First Nations, Aboriginal, Inuit, or Métis. We also included people who self-reported being a member of any Indigenous group or nation (e.g., Haida, Iroquois, etc.). Among these individuals, we included all 180-day observation periods which included ≥1 day of ART dispensation as indicated through the confidential linkage to the ART dispensary.

The primary outcome of interest was adherence to ART in the previous 180 days. We measured adherence in each six-month period as the number of days for which ART had been dispensed over the number of days since that individual had first been dispensed ART, capped at 180 days. This quotient was dichotomized into optimal adherence vs. sub-optimal adherence (i.e., ≥95 vs. <95%). We have used this previously validated measure of adherence based on prescription refill compliance extensively [17, 19, 20], and have shown it is strongly and positively associated with viral response and survival [17, 21, 22].

The primary explanatory variable of interest was engagement in a maximally-assisted therapy-based programme (MAT), defined as 180 day observation periods in which dispensary records indicated that ≥1 day of ART had been dispensed at a MAT-based programme. We also considered a range of covariates that could be associated with either engagement in MAT or adherence to ART, including: age at baseline (per year older); gender (non-male vs. male); residing in the Downtown Eastside (yes vs. no); unstable housing, defined as living in a single-room occupancy hotel, homeless shelter, hostel, treatment or recovery house or having no fixed address (yes vs. no); living in a stable relationship, defined as being legally married, common law, or having a regular partner (yes vs. no); level of educational attainment (≥high school diploma vs. <high school diploma); being incarcerated in the last six months, defined as spending at least one night in jail, prison or penitentiary (yes vs. no); injection drug use in the last six months (yes vs. no); non-injection drug use in the last six months (yes vs. no); employment in the last six months, defined as having at least one source of income from a regular or temporary employment or being self-employed (distinguished from non-legal forms of income generation by separate response options) (yes vs. no); enrollment in any type of addiction treatment in the last six months (yes vs. no); and CD4+ cell count (per 100 cells/mL). Except for housing status, which referred to current status, all other variables referred to behaviours or exposures in the last six months prior to the study interview. For CD4 cell count, we used the median of all observations in the previous 180 days conducted either through the study or by the participant's physician or, if none, the most recent observation.

As a first step, we compared baseline characteristics of participants who had been exposed to a MAT-based programme versus those who had not, using Chi-square test for binary measures and Wilcoxon's rank sum test for continuous measures. Next, to determine the longitudinal relationship between engagement in MAT and optimal adherence independent of possible confounders, we used generalized linear mixed-effects models (GLMM), which account for within-individual similarities across repeated measures over the study period. First, bivariable GLMM analyses were performed to calculate the unadjusted odds ratios and 95% confidence intervals of the associations between the explanatory variables of interest and optimal adherence. We then fit a multivariable GLMM to measure the effect of MAT on optimal adherence, controlling for a range of potential confounders, which were fixed to the model. Variables that had a p-value less than 0.05 in bivariable GLMM were included in the multivariable GLMM.

Next, to account for the nonrandomized nature of observational data, we employed a marginal structural modeling procedure. In brief, marginal structural models measure the causal effect of a time-dependent exposure in the presence of time-dependent covariates

using observational data [14, 23, 24]. In the current study, we sought to estimate the difference in mean adherence that would have been observed if the entire cohort had received the intervention versus if no one had received the intervention. This model assumes that there are no unmeasured confounders, or that, among individuals who are identical with respect to all measured covariates, the observed adherence of individuals who received the intervention is representative of the counterfactual adherence – this is known as the randomization assumption [14].

Behavioural and drug use variables, based on activities in the last six months, were treated as time-updated covariates. Further, variables that had missing values were imputed by carrying the most recent observation forward. To ensure that potential confounders occurred before exposure to a MAT-based programme, time-lagged confounder measurements were used. Specifically, inverse probability-of-treatment weights (IPTW) calculated using pooled logistic regression was applied for the marginal structural model. IPTW can be used to adjust for measured confounding and selection bias in our sample by reweighting the dataset. Other models are susceptible to produce biased causal effect estimates when the existing time-dependent confounders are themselves affected by previous treatment [25]. Using IPTW, each individual was assigned a weight inversely proportional to the individual's probability of receiving the treatment (engagement in MAT or not) that they in fact received [15]. By weighting the dataset, we can estimate the difference of 95% ART adherence that would have been observed between those who engaged in MAT versus those who did not, if MAT had been assigned randomly. This stabilized weighted procedure has been previously described by Hernán and colleagues [23]. Finally, a weighted repeated measures model analysis using generalized estimating equations was employed to estimate the effect of exposure to MAT. All statistical analyses were performed using the SAS software version 9.4 (SAS, Cary, NC). All *p*-values are two sided with a significance level of 0.05.

RESULTS

In total, 354 HIV-positive Indigenous participants who had ≥1 day of ART dispensation prior to the end of the study period were included in these analyses. Among these participants, 311 (88%) identified as First Nations, two (<1%) as Inuit, and 41 (12%) as Métis. Further, 179 (50.6%) participants in our sample identified as male and the median age was 42 (interquartile range [IQR]: 35–47). These 354 participants contributed to 3319 observations over the study period, equal to 1819 person-years of observation. The median number of study visits was 9 (IQR: 4–14), and the median follow-up time per participant was 63.4 months (IQR: 29.1–90.5), with a loss to follow-up of 12.2% over the study period as previously defined [26]. Of note, this rate does not include the 83 (23.4%) participants that died over the study period. Individuals in our sample frequently reported several known barriers to optimal treatment outcomes. For example, 247 (69.8%) were unstably housed or homeless, 256 (72.3%) reported injection drug use, and 40 (11.3%) had been recently incarcerated at their baseline study visit. Figure 1 depicts self-reported drug use patterns among our sample over the study period.

At baseline, 24 (68.6%) of participants in MAT achieved ≥95% adherence compared to 160 (50.2%) not in MAT (p=0.038). Among the 55 participants that were engaged in the MAT programme (n=35 at baseline and 20 additional participants over follow-up), based on a participant's total number of study visits, 40.0% were engaged in MAT ≥80% of the time; 10.9% were engaged in MAT 79–60% of the time; 18.2% were engaged 59–40% of the time; 18.2x% were engaged 40–20% of the time; and 12.7% were engaged in MAT <20% of the time over the study period. See Figure 2 for the proportion of the sample that was engaged in MAT 100% over the study period. Baseline characteristics of the study sample, stratified by exposure to a MAT-based programme in the 180-day period prior to the first study interview are presented in Table 1. The results of the bivariable and multivariable GLMM are shown in Table 2. In multivariable analysis, engagement in MAT was found to be significantly and positively associated with increased odds of achieving optimal adherence to ART, after controlling for factors including age, any illicit drug use (i.e., injection or non-injection, other than cannabis), enrollment in addiction treatment, and CD4+ cell count (Adjusted Odds Ratio [AOR]=4.92; 95% confidence interval [CI]: 3.18–7.62). After employing a marginal structural model with the same covariates as above and adjusting for the stabilized weights in generalized estimating equations (Table 2), engagement in MAT was found to be strongly associated with the likelihood of achieving optimal adherence to ART (AOR=5.76; 95% CI: 3.34–9.96).

DISCUSSION

In this study, we observed a strong, independent and longitudinal link between engagement in a MAT-based programme and the achievement of optimal adherence among Indigenous people living with HIV/AIDS. Our findings stand in strong contrast to many earlier studies conducted across Canada, in which treatment and care systems were unable to deliver comparable HIV/AIDS treatment outcomes between Indigenous and non-Indigenous people living with HIV/AIDS [5, 6, 27]. Previous research has demonstrated that Indigenous populations do not, or are unable to, access HIV testing, care or be retained in treatment with the same frequency as non-Indigenous people [27, 28]; while multiple qualitative studies have linked the prevalence of institutional and provider distrust in HIV testing and care with the long history of discriminatory policies and practices of the Canadian government [29, 30]. Indeed, scholars have associated the generally poor health outcomes among Indigenous peoples to a health care system founded on systemic racism and colonialism [31]. As such, studies of HIV treatment outcomes among Indigenous peoples, including our own, should be interpreted within the context of the social and structural determinants of health including continued social, economic, political and cultural marginalization [32–36].

Previous studies have demonstrated that directly observed therapy-based programmes can improve HIV treatment adherence and virologic outcomes among HIV-positive people who use drugs, primarily through interventions nested within methadone programmes for opioid-dependent individuals [9, 37]. The current results add to this evidence by describing superior adherence levels among Indigenous individuals exposed to a maximally-assisted therapy-based intervention. When the MAT programme was established in 1999, Vancouver was experiencing an escalating rate of HIV infection among many populations, including Indigenous residents. Earlier studies conducted in our setting prior to the beginning of

efforts to scale-up access and adherence to antiretroviral therapy in 2004 [26], found that Indigenous peoples were less likely to initiate ART [38], and more likely to die from AIDS without having ever received ART [39]. However, as Milloy *et al.* demonstrated in a recent study conducted in Vancouver from 2005 to 2014, no statistically significant differences were found between Indigenous and non-Indigenous people living with HIV on several key treatment outcomes; including, access to ART, viral load, and achieving optimal adherence to ART [18]. These findings, in conjunction with ours, suggest that MAT-based programmes were part of a comprehensive policy response to improve treatment outcomes among Indigenous individuals experiencing multiple barriers to care. As rates of new HIV infections on numerous reserves in Saskatchewan have reached levels equivalent to areas with generalized epidemics of HIV/AIDS [40], our findings suggest that the scale-up of MAT-based programmes may prove to be an important factor in responding to HIV among Indigenous peoples in Canada.

Our study has several limitations. As in all observational studies, our sample was not selected at random and our findings may not be representative of other vulnerable HIV-infected populations. We also recognize that many of our measures rely on self-report and are vulnerable to socially desirable reporting, although we note that in the current study both the outcome and primary explanatory variables of interest were gathered from administrative sources of data. Finally, there is increasing awareness of the importance of Indigenous-led systems to identify Indigenous individuals, especially in government and research data, to aid in decolonization, self-government and reconciliation efforts. Our analysis relied on self-reported status, which might under- or overstate important aspects of Indigeneity in this setting. In future, all researchers should seek to use a standard approach to identifying Indigenous persons, such as the Aboriginal Administrative Data Standard [41].

In conclusion, this study demonstrated that engagement in the MAT programme significantly increased the odds in achieving optimal adherence for HIV treatment among Indigenous individuals living with HIV who use illicit drugs. Given the public health concerns regarding HIV transmission and the repeated calls for improved treatment options for Indigenous peoples living with HIV/AIDS, our study findings indicate that MAT-based programmes may be an effective part of the HIV care cascade and that efforts to scale-up similar programs in other settings are warranted.

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REFERENCES

[1]. BC Centre for Disease Control. HIV in British Columbia: Annual Surveillance Report 2012. Vancouver, Canada; 2013.

[2]. Public Health Agency of Canada. HIV/AIDS Epi Updates - Chapter 1: National HIV Prevalence and Invidence Estimates for 2011. Ottawa, Canada: Government of Canada, 2014 Available: http://www.phac-aspc.gc.ca/aids-sida/publication/epi/2010/1-eng.php (accessed 2016 November 15).

[3]. Montaner JSG, Lima VD, Harrigan PR, et al. Expansion of HAART coverage is associated with sustained decreases in HIV/AIDS morbidity, mortality and HIV transmission: The "HIV Treatment as Prevention" experience in a Canadian setting. PLoS ONE 2014;9(2):e87872. [PubMed: 24533061]

[4]. Wolfe D, Carrieri MP, Shepard D. Treatment and care for injecting drug users with HIV infection: a review of barriers and ways forward. The Lancet 2010;376:355–366.

[5]. Martin LJ, Houston S, Yasui Y, et al. All-cause and HIV-related mortality rates among HIV-infected patients after initiating Highly Active Antiretroviral Therapy: The impact of Aboriginal ethnicity and injection drug use. Canadian Journal of Public Health 2011;102:90–96. [PubMed: 21608378]

[6]. Martin LJ, Houston S, Yasui Y, et al. Rates of initial virological suppression and subsequent virological failure after initiating Highly Active Antiretroviral Therapy: The impact of Aboriginal ethnicity and injection drug use. Current HIV Research 2010;8:649–658. [PubMed: 21187007]

[7]. Fontanarosa PB, Babudieri S, Aceti A, et al. Directly observed therapy to treat HIV infection in prisoners. JAMA 2000;284:179–180. [PubMed: 10889588]

[8]. Myung P, Pugatch D, Brady MF, et al. Directly observed Highly Active Antiretroviral Therapy for HIV-infected children in Cambodia. American Journal of Public Health 2007;97:974–977. [PubMed: 17463375]

[9]. Mitty JA, Macalino GE, Bazerman LB, et al. The use of community-based modified Directly Observed Therapy for the treatment of HIV-infected persons. JAIDS 2005;39:545–550. [PubMed: 16044005]

[10]. Community AIDS Treatment Information Exchange (CATIE). Maximally Assisted Therapy (MAT) Program. Toronto, Canada: CATIE, 2013 Available at: http://www.catie.ca/en/pc/program/mat-program (accessed 2016 December 2).

[11]. Vancouver Native Health Society. Positive Outlook Program. In. Vancouver, Canada: Vancouver Native Health Society; 2016 Available at: http://www.vnhs.net/programs-services/positive-outlook-program (access 2018 April 23).

[12]. Parashar S, Palmer AK, O'Brien N, et al. Sticking to it: The effect of Maximally Assisted Therapy on antiretroviral treatment adherence among individuals living with HIV who are unstably housed. AIDS and Behavior 2011;15:1612–1622. [PubMed: 21850442]

[13]. Tyndall MW, McNally M, Lai C, et al. Directly observed therapy programmes for anti-retroviral treatment amongst injection drug users in Vancouver: Access, adherence and outcomes. The International Journal on Drug Policy 2007;18:281–287. [PubMed: 17689376]

[14]. Petersen ML, Wang Y, van der Laan MJ, et al. Assessing the effectiveness of antiretroviral adherence interventions: Using Marginal Structural Models to replicate the findings of Randomized Controlled Trials. JAIDS 2006;43 Suppl 1:S96–S103. [PubMed: 17133209]

[15]. Petersen ML, Wang Y, van der Laan MJ, et al. Pillbox organizers are associated with improved adherence to HIV antiretroviral therapy and viral suppression: A Marginal Structural Model analysis. Clinical Infectious Diseases 2007;45:908–915. [PubMed: 17806060]

[16]. Yip B, Palepu A, Montaner JSG, et al. Barriers to use of free antiretroviral therapy in injection drug users. JAMA 1998;280:547–549. [PubMed: 9707146]

[17]. Wood E, Hogg RS, Lima VD, et al. Highly Active Antiretroviral Therapy and survival in HIV-infected injection drug users. JAMA 2008;300:550. [PubMed: 18677027]

[18]. Milloy MJ, King A, Kerr T, et al. Improvements in HIV treatment outcomes among Indigenous and non-Indigenous people who use illicit drugs in a Canadian setting. Journal of the International AIDS Society 2016;19:1–8.

[19]. Nolan S, Milloy MJ, Zhang R, et al. Adherence and plasma HIV RNA response to antiretroviral therapy among HIV-seropositive injection drug users in a Canadian setting. AIDS Care 2011;23:980–987. [PubMed: 21480010]

[20]. Low-Beer S, Yip B, O'Shaughnessy MV, et al. Adherence to triple therapy and viral load response. JAIDS 2000;23:360–361. [PubMed: 10836763]

[21]. Wood E, Hogg RS, Yip B, et al. Effect of medication adherence on survival of HIV-infected adults who start highly active antiretroviral therapy when the CD4(+) cell count is 0.200 to 0.350 X 109 cells/L. Annals of Internal Medicine 2003;139:810–816. [PubMed: 14623618]

[22]. Gross R, Yip B, Re VL III, et al. A simple, dynamic measure of antiretroviral therapy adherence predicts failure to maintain HIV-1 suppression. Journal of Infectious Diseases 2006;194:1108–1114. [PubMed: 16991085]

[23]. Hernán MA, Brumback BA, Robins JM. Estimating the causal effect of zidovudine on CD4 count with a Marginal Structural Model for repeated measures. Statistics in Medicine 2002;21:1689–1709. [PubMed: 12111906]

[24]. Robins JM, Hernán MÁ, Brumback B. Marginal Structural Models and causal inference in epidemiology. Epidemiology 2000;11:550–560. [PubMed: 10955408]

[25]. Hernán MA, Hernández-Díaz S, Robins JM. A structural approach to selection bias. Epidemiology 2004;15:615–625.26. [PubMed: 15308962]

[26]. Milloy M-J, Wood E, Kerr T, Hogg B, Guillemi S, Harrigan PR, et al. Increased prevalence of controlled viremia and decreased rates of HIV drug resistance among HIV-positive people who use illicit drugs during a community-wide Treatment-as-Prevention initiative. Clinical Infectious Diseases 2016; 62(5):640–647. [PubMed: 26553011]

[27]. Erickson A, Becker M, Shaw S, et al. Substance use and its impact on care outcomes among HIV-infected individuals in Manitoba. AIDS Care 2015;27:1168–1173 [PubMed: 25930982]

[28]. Prentice T, Mill J, Archibald CP, et al. Aboriginal youth experiences of accessing HIV care and treatment. Journal of HIV/AIDS & Social Services 2011;10:395–413.

[29]. McCall J, Browne AJ, Reimer-Kirkham S. Struggling to survive: the difficult reality of Aboriginal women living with HIV/AIDS. Qualitative Health Research 2009;19:1769–1782. [PubMed: 19949225]

[30]. Larkin J, Flicker S, Koleszar-Green R, et al. HIV risk, systemic inequities, and Aboriginal youth: widening the circle for HIV prevention programming. Canadian Journal of Public Health 2007:179–182. [PubMed: 17626380]

[31]. Matthews R The cultural erosion of Indigenous people in health care. Canadian Medical Association Journal 2016: published ahead of print.

[32]. Rourke SB, Sobota M, Tucker R, et al. Social determinants of health associated with hepatitis C co-infection among people living with HIV: results from the Positive Spaces, Healthy Places study. Open Medicine 2011;5:e120. [PubMed: 22046224]

[33]. Mehrabadi A, Craib KJP, Patterson K, et al. The Cedar Project: A comparison of HIV-related vulnerabilities amongst young Aboriginal women surviving drug use and sex work in two Canadian cities. International Journal of Drug Policy 2008;19:159–168. [PubMed: 17870461]

[34]. Spittal PM, Craib KJP, Teegee M, et al. The Cedar Project: Prevalence and correlates of HIV infection among young Aboriginal people who use drugs in two Canadian cities. International Journal of Circumpolar Health 2007;66:226–240. [PubMed: 17655063]

[35]. Craib KJ, Spittal PM, Patel SH, et al. Prevalence and incidence of hepatitis C virus infection among Aboriginal young people who use drugs: results from the Cedar Project. Open Medicine 2009;3:e220. [PubMed: 21688759]

[36]. Public Health Agency of Canada. Population-Specific HIV/AIDS Status Report: Aboriginal Peoples. Ottawa, Canada: Government of Canada, 2010 Available: http://www.phac-aspc.gc.ca/aids-sida/publication/ps-pd/index-eng.php (accessed 2016 November 4).

[37]. Lucas GM, Mullen BA, Weidle PJ, et al. Directly administered antiretroviral therapy in methadone clinics is associated with improved HIV treatment outcomes, compared with outcomes among concurrent comparison groups. Clinical Infectious Diseases 2006;42:1628–1635. [PubMed: 16652321]

[38]. Wood E, Kerr T, Palepu A, et al. Slower uptake of HIV antiretroviral therapy among Aboriginal injection drug users. Journal of Infection 2006;52:233–236. [PubMed: 16169594]

[39]. Wood E, Montaner JSG, Tyndall MW, et al. Prevalence and correlates of untreated Human Immunodeficiency Virus Type 1 infection among persons who have died in the era of modern antiretroviral therapy. The Journal of Infectious Diseases 2003;188:1164–1170. [PubMed: 14551887]

[40]. Vogel L HIV in Saskatchewan merits urgent response. Canadian Medical Association Journal 2015;187:793–794. [PubMed: 26124233]

[41]. British Columbia Ministry of Aboriginal Relations and Reconcilliation. Government Standard for Aboriginal Administrative Data. Victoria, Canada: Government of British Columbia, 2007 Available: http://www2.gov.bc.ca/assets/gov/government/services-for-government-and-broader-public-sector/information-technology-services/standards-files/aboriginal_administrative_data_standards.pdf (accessed 2016 May 6).

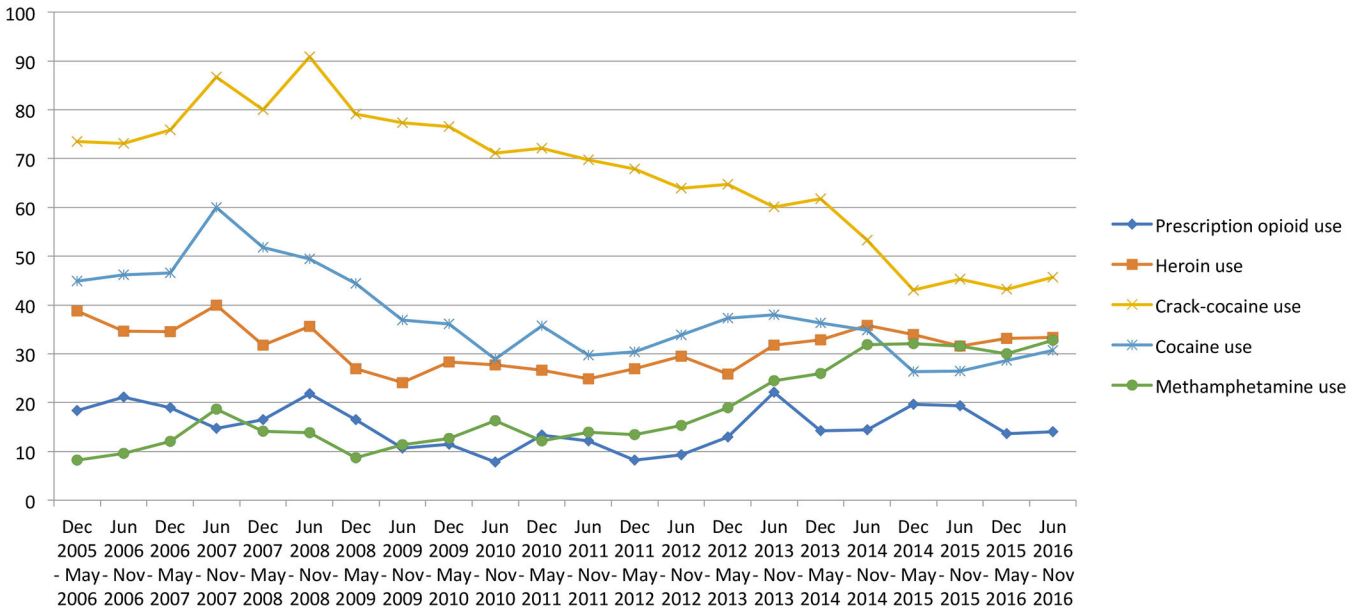

Figure 1.

Drug use patterns among Indigenous people living with HIV in Vancouver, Canada from Dec 2005-Nov 2016 (n=354)

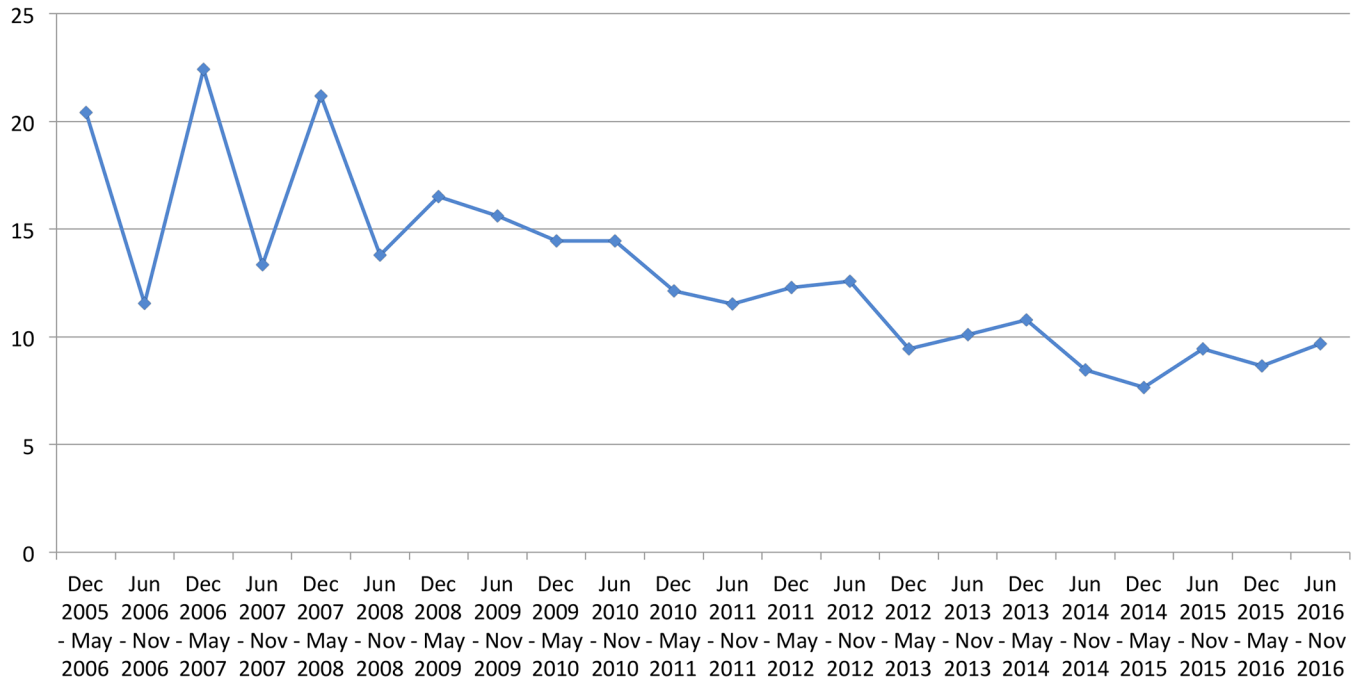

Figure 2.
Percentage of sample engaged in MAT 100% of the time from Dec 2005-Nov 2016.

Table 1.

Baseline sociodemographic characteristics and substance use behaviours stratified by exposure to a MAT programme among Indigenous individuals with ≥ 1 day of ART dispensation in the previous 180 days (n=354).

	Maximally-assisted therapy[ab]			
Characteristic	**Total 354 (100%)**	**Yes 35(9.9%)**	**No 319 (90.1%)**	***p-value***
Optimal adherence[a]				
Yes	184 (52.0)	24 (68.6)	160 (50.2)	0.038
No	170 (48.0)	11 (31.4)	159 (49.8)	
Age				
Median, IQR[d]	42 (35–47)	41 (35–46)	42 (35–47)	0.468
Gender				
Non-male	175 (49.4)	18 (51.4)	157 (49.2)	0.804
Male	179 (50.6)	17 (48.6)	162 (50.8)	
Housing instability				
Yes	247 (69.8)	26 (74.3)	221 (69.3)	0.427
No	103 (29.1)	8 (22.9)	95 (29.8)	
Lives in DTES[ae]				
Yes	247 (69.8)	30 (85.7)	217 (68.0)	0.033
No	107 (30.2)	5 (14.3)	102 (32.0)	
Stable relationship[a]				
Yes	116 (32.8)	13 (37.1)	103 (32.3)	0.532
No	231 (65.3)	21 (60.0)	210 (65.8)	
Education				
≥High school	144 (40.7)	17 (48.6)	127 (39.8)	0.220
<High school	203 (57.3)	16 (45.7)	187 (58.6)	
Incarceration[a]				
Yes	40 (11.3)	4 (11.4)	36 (11.3)	1.000
No	312 (88.1)	31 (88.6)	281 (88.1)	
Injection drug use[a]				

Characteristic	Total 354 (100%)	Maximally-assisted therapy[ab] Yes 35(9.9%)	No 319 (90.1%)	*p-value*
Yes	256 (72.3)	24 (68.6)	232 (72.7)	0.746
No	95 (26.8)	10 (28.6)	85 (26.6)	
Non-injection drug use[a]				
Yes	319 (90.1)	35 (100.0)	284 (89.0)	0.035
No	35 (9.9)	0 (0.0)	35 (11.0)	
Employment[a]				
Yes	61 (17.2)	6 (17.1)	55 (17.2)	0.988
No	293 (82.8)	29 (82.9)	264 (82.8)	
Addiction treatment[a]				
Yes	185 (52.3)	19 (54.3)	166 (52.0)	0.858
No	165 (46.6)	16 (45.7)	149 (46.7)	
CD4+ count[a,f]				
Median (IQR)	2.9 (1.7–4.4)	2.6 (1.9–4.9)	3.0 (1.7–4.4)	0.995

Note: All column percentages may not sum to 100% due to missing data or rounding error.

[a] Denotes activities in the last six months;

[b] Variable coded ‘yes’ if ≥ 1day ART dispensed through Maximally-Assisted Therapy in last six months, ‘no’ if < 1 day ART dispensed through non-MAT;

[c] CI = Confidence Interval;

[d] IQR = Interquartile Range;

[e] DTES = downtown eastside, Vancouver’s drug scene epicenter;

[f] Per 100 cells/mL

Table 2.

Bivariable and multivariable results of the GLMM and marginal structural modeling for factors associated with ≥95% adherence to ART among Indigenous individuals with ≥ 1 day of ART dispensation in the previous 180 days (n=354)

	Generalized Linear Mixed Effects Model		*Marginal Structural Model*
Characteristic	**Odds Ratio, (95% CI[a])**	**Adjusted Odds Ratio, (95% CI)**	**Adjusted Odds Ratio, (95% CI)**
Maximally-assisted therapy[bc]			
Yes *vs.* no	4.43 (2.85 – 6.89) *	4.92 (3.18 – 7.62) *	5.76 (3.34 – 9.96) *
Age at baseline			
Per year older	1.02 (1.00 – 1.04)	1.03 (1.01 – 1.05)	
Gender			
Non-male *vs.* male	0.78 (0.56 – 1.07)		
DTES[cd]			
Yes *vs.* no	0.93 (0.75 – 1.15)		
Housing instability			
Yes *vs.* no	0.86 (0.69 – 1.06)		
Stable relationship[c]			
Yes *vs.* no	1.14 (0.92 – 1.43)		
High school completion			
Yes *vs.* no	0.98 (0.70 – 1.36)		
Incarceration[c]			
Yes *vs.* no	0.90 (0.62 – 1.30)		
Injection drug use[c]			
Yes *vs.* no	0.60 (0.48 – 0.75) *	0.68 (0.55 – 0.84) *	
Non-injection drug use[c]			
Yes *vs.* no	0.65 (0.51 – 0.83) *	0.74 (0.58 – 0.94)	
Employment[c]			
Yes *vs.* no	1.04 (0.81 – 1.33)		
Addiction treatment[c]			

	Generalized Linear Mixed Effects Model		*Marginal Structural Model*
Characteristic	**Odds Ratio, (95% CI[a])**	**Adjusted Odds Ratio, (95% CI)**	**Adjusted Odds Ratio, (95% CI)**
Yes *vs.* no	1.44 (1.15 – 1.81)	1.58 (1.27 – 1.98) *	
CD4+ cell count[c]			
Per 100 cells/mL	1.21 (1.15 – 1.28) *	1.19 (1.13 – 1.26) *	

Note:

[a] CI = Confidence Interval;

[b] Variable coded ‘yes’ if ≥ 1day ART dispensed through Maximally Assisted Therapy in last six months, ‘no’ if < 1 day ART dispensed through non-MAT;

[c] denotes characteristic in last six months;

[d] DTES = Downtown Eastside;

* *p*-value <0.001

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